the Gulf States and the two Navy stations at Colon and Santo Domingo, will form a "network which, it is believed, will furnish information of great value in the study of these destructive storms and in forecasting their direction and rate of movement." Whether or not hurricanes occur, observations will be made twice daily and the data on trades, antitrades, etc., will well repay the effort, for very little is known of the winds aloft in those regions. If funds permit, this program will be extended during the next several years.

Not only is it essential that means be provided for the extension of pilot balloon work in the West Indies, but also in the United States proper. At present there are about two dozen stations sending daily reports of free-air wind conditions to the forecast centers of the Weather Bureau. This information forms the basis of forecasts that are issued for the information of aviators in the Aerial Mail Service and the Army and Navy Air Services. At least fifty, and preferably a hundred, additional stations are needed. It would be possible, with such a net-work, to construct upper-air wind charts from which accurate and detailed forecasts could be made. It is to be hoped that Congress will see the importance of providing this additional equipment, for its installation would find a direct and immediate reflection in the increased safety of aviation, and in the increased efficiency of our aerial services.

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SPECIAL ARTICLES

NOTE ON EINSTEIN'S THEORY OF GRAVITATION AND LIGHT

THIS paper contains a statement of some apparently unnoticed results dealing with light rays and orbits in Einstein's general theory of gravitation. The full proofs will be published in the mathematical journals.

We recall briefly that Einstein, in his general relativity theory, introduces ten potential functions g_{ik} (in contrast with the single function appearing in the Newtonian theory); these are the coefficients in the fundamental quadratic form

$$ds^2 = \Sigma g_{ik} dx_i dx_k,$$

which defines the four-dimensional space-time world $(x_1 x_2 x_3 x_4)$. When there is no actual gravitation the manifold can be written in the euclidean form $dx_1^2 + dx_2^2 + dx_3^2 + dx_4^2$, or $dx^2 + dy^2 + dz^2 - dt^2$ in the usual coordinates. The path of a free particle is then straight, and so is the path of a light pulse.

In the general gravitational case, the ten potentials obey (in space not occupied by matter) a certain set of ten differential equations of the second order $R_{ik} = 0$, where the left-hand members are the components of what is known in the literature as "the contracted Riemann-Christoffel curvature tensor" (Why not call it simply the Einstein tensor?). A free particle then describes a geodesic, or path of minimum length s. Light rays are found by adjoining the condition that ds vanishes. When the quadratic form is put equal to zero, the result will be described as the *light equation.*

I. Our first result is that if an Einstein manifold has straight geodesics it is necessarily euclidean. This means that if, in an unknown field with vanishing Einstein tensor, coordinates can be introduced such that the paths of all particles are expressible by linear equations, then the field is free from gravitation. It is to be noted that curved four-dimensional manifolds with linear geodesics exist: but our result shows that they do not obey Einstein's equations.

II. An analogous result holds for light rays. If in an unknown Einstein field four coordinates can be introduced so that the light equation takes the usual form $dx^2 + dy^2 + dz^2 - dt^2 = 0$, then there is no gravitation (that is, the manifold is euclidean). This requires proof since an arbitrary function may be introduced as factor in the first member without changing the light equation, although this in general changes the field and the geodesics.

III. We pass now to general manifolds where the paths can not be regarded as

straight lines, so that an actual gravitational field exists. We show that the totality of curved paths completely determines the field. Two Einstein fields which are essentially distinct can never have the same paths. In particular, the paths completely determine the behavior of light.

IV. Our final theorem is that the light equation determines uniquely the gravitational field. In particular, the paths of particles can be predicted from the behavior of light in the field.

It follows that the gravitational field produced by the sun can be explored *either* by observations on the orbits of the planets *or* by observations on the deflection of light rays. *It is not necessary to use both sets of observations.* There is, in particular, a connection between the deflection of light (1.7″ at the sun's limb) and the motion of the perihelion of Mercury (43″ per century): either could have been *theoretically* predicted from the other—but in this fairyland who can lay down a boundary between theory and practise?

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(*Concluded*)

Some proteins from the Georgia velvet bean, Stizolobium Deeringianum: C. O. Johns and H. C. Waterman. The Georgia velvet bean contains 23.6 per cent. of protein (N × 6.25). Salt solutions of optimum concentrations (3 per cent.) extract about 15 per cent. of protein. From such solutions 2 globulins, designated the α- and β-globulins, and an albumin may be separated, the 2 former by fractionation with ammonium sulfate and the latter by coagulation from extracts from which the globulins have been precipitated by prolonged dialysis. The proteins are sharply distinguished by their different sulfur- and nitrogen-content, by differences in the percentages of the basic amino-acids as determined by Van Slyke's method, and by the fact that the *β-globulin* does not give the Hopkins reaction for *tryptophane.* The latter observation is of particular interest inasmuch as this amino-acid has been found in all seed globulins heretofore tested. The α-globulin and the albumin from the Georgia velvet bean both contain tryptophane.

The deficiency of cystine in proteins of the genus phaseolus: C. O. Johns and A. J. Finks. Nutrition experiments with the proteins of the navy bean, *Phaseolus vulgaris,* lima bean, *Phaseolus lunatus,* and adsuki bean, *Phaseolus angularis,* show that they are deficient in cystine. This amino-acid must be added before they are adequate for normal growth. The proteins of the navy and lima beans must be cooked as well as supplemented with cystine before they are available. Similar experiments are in progress with the mung bean, *Phaseolus aureus.*

Studies on Neoarsphenamines: P. A. Kober. It was shown in a previous paper that arsphenamine made by Ehrlich's method contains methylalcohol. It is now shown that neo- and sodium arsphenamines made heretofore contain about 30–40 per cent. impurities, consisting chiefly of methyl alcohol, ethyl alcohol, sulphites and ether. Methods were described for the first time, for making sodium arsphenamine, neo-arsphenamine and a soluble mono-hydrochloride of arsphenamine base, which are chemically pure and whose arsenic and sulfur content is close to that required by the theory. Another method was described for making the dihydrochloride of arsphenamine base.

The colorimetric estimation of tyrosine by the method of Folin and Denis: Ross Aiken Gortner and George E. Holm. As the result of a study of the various factors influencing the color intensity of protein hydrolysates to which have been added the phenol reagent of Folin and Denis, according to their directions for the quantitative estimation of tyrosine, we are forced to conclude that: (1) Tyrosine can not be quantitatively estimated in a protein hydrolysate by the use of the phenol reagent because (2) Tryptophane, if present, will also produce intense colors with the reagent, the color produced by one milligram being approximately 85 per cent. of that produced by tyrosine at an equivalent concentration. (3) Indole and indole derivatives, contrary to the statement of Folin and Denis, react strongly with the phenol reagent to produce the blue color. (4) Ferrous iron, and apparently any other easily oxidizable material, also reacts with the reagent. (5) There is considerable evidence that tyrosine and tryptophane are not the only protein constituents which produce blue colors with the phenol reagent. (6) The amount of color which is developed in a solution is not a linear function of the concentration of the reactive material, but the color values fall off